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D. RemarksAmendments to Specification.

The Specification has been amended to address a typographical error. The chemical
5 formula for ammonium hydroxide has been corrected from NH_2OH to NH_4OH .

Rejection of Claims 1-3, 6-7, 9-13, 15-17 and 19-20 Under 35 U.S.C. §103(a), based on U.S.
Patent No. 6,014,979 (*Van Autryve et al.*) in view of Applicants' Background Art (*Background*
Art), further in view of U.S. Patent No. 5,660,640 (*Laube*), U.S. Patent No. 6,352,081 (*Lu et al.*),
10 and U.S. Patent No. 5,391,275 (*Mintz*)

The rejection of claims 1-3, 6-7 and 9 will first be addressed.

The invention of amended claim 1 is directed to a method that includes cleaning a plasma
reactor chamber part of a material redistributed thereon by a reactive plasma process by placing
the chamber part in a redistributed material solvent for at least 6 hours. The method also
15 includes cleaning the chamber part with a plasma that includes oxygen as a source gas. In
addition, the chamber part may be ultrasonically cleaned. The redistributed material includes
photoresist polymers and the solvent includes acetone.

As is well known, to establish a prima facie case of obviousness, a rejection must meet
three basic criteria. First, there must be some suggestion or motivation to modify a reference or
20 combine reference teachings. Second, there must be a reasonable expectation of success.
Finally, the prior art reference(s) must teach or suggest all claim limitations.

The reference *Van Autryve et al.* does not show or suggest "placing a chamber part in a
redistributed material solvent including acetone for at least six hours". This is apparently
admitted by the rejection.¹ However, the remaining references are not believed to show or
25 suggest such a limitation, either.

Applicants' *Background Art* and the references *Laube* and *Mintz* never mention acetone.
Accordingly, these references cannot show or suggest the limitations of claim 1.

The remaining reference *Lu et al.* shows a cleaning method that employs the ketone
hexafluoropentanedione (hexafluoroacetylacetone or H+hfac). However, this chemical is not
30 utilized as a solvent for photoresist polymers, but rather is used to remove oxidized copper

¹ See the Office Action, dated 12/17/2003, Page 3, Lines 16-17.

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containing byproducts.² Thus, this reference does not show or suggest Applicants' claim 1 limitations.

Thus, because the combination of references does not show all limitations of claim 1, this ground for rejection is traversed.

5

The rejection of claims 10-13 will now be addressed.

The invention of amended claim 10 is directed to a method of cleaning a plasma reactor chamber part. The method includes plasma cleaning a chamber part of a material redistributed on the chamber part by a reactive plasma process, with a plasma having an etch selectivity
10 between the chamber part and the redistributed material that is greater than 1:100. The method further includes cleaning the chamber part with an organic solvent of the redistributed material by placing the chamber part in the solvent of the redistributed material prior to the plasma cleaning.

Thus, Applicants' amended claim 10 includes an order to the cleaning method in which a
15 chamber part is placed in an organic solvent and then plasma cleaned.

As noted above in the comments for claims 1-3, 6-7 and 9, the rejection appears to admit that *Van Autryve et al.* does not show the placing of a chamber part in a solvent, and hence does not show placing a chamber part into an organic solvent prior to a plasma clean. However, the remaining references are not believed to show or suggest such a limitation, either.

20 Applicants' *Background Art* does not describe the use of organic solvents. The reference *Laude* and *Mintz* appear to be silent as to organic solvents, and thus cannot show or suggest the above limitations.

The remaining reference *Lu et al.* teaches away from the order set forth in claim 10. In *Lu et al.* a chamber is purposely subjected to an oxidation step, which can include a plasma of
25 oxygen (O₂). Afterward, the chamber can be exposed to gaseous H+hfac. The need for this particular order is highly stressed in the reference.

It is very important that the copper-containing byproducts be oxidized to Cu⁺² in order for them to react with, and be volatilized by, H⁺hfac during subsequent

² See *Lu et al.*, Col. 11, Lines 4-11.

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cleaning steps.³

Thus, *Lu et al.* appears to each essentially the opposite of Applicants' amended claim 10 arrangement, in which a chamber part is cleaned in a solvent and then subjected to a plasma
5 clean.

Thus, because the cited references do not show or suggest all limitations of claim 10, this ground for rejection is traversed.

Additionally, Applicants note that the rejection set forth a particular interpretation of the term "selectivity":

10

[I]t is noted that the claims recite only one low limitation for the selectivity and do not exclude selectivity being 2:100 or even 1000:100. It means that even the process wherein the part of the chamber is preferentially etched by plasma compared to the contaminants is inside of the claims.⁴

15

Applicants respectfully disagree. Selectivity refers to relative etch rates. Thus, claim 1 recites relative etch rates between (chamber part):(redistributed material) of 1:100. Importantly, "selectivity" is determined according to the layer to be etched (in this case the redistributed material). Thus, a greater selectivity refers to a relatively greater etch rate for the layer to be
20 etched. Applicants submit herewith Exhibit A to show this well understood meaning.

It is noted, this understanding is understood and followed by Office Actions previously issued in the case⁵. Further, Applicants' Specification (as amended in the Response to Office Action of 3/13/2003) further supports this interpretation.

For all of these reasons, it is believed that a prima facie case of obviousness has not been
25 established for these claims, and this ground for rejection is traversed.

The rejection of claims 15-16 and 19-20.

The invention of amended claim 15 is directed to a method of cleaning reactive plasma

³ *Lu et al.*, Col. 10, Lines 58-62.

⁴ See the Office Action, dated 12/17/03, Page 3, Lines 8-11.

⁵ See the Office Action, dated 12/06/2001, Page 3, 6-8th lines from the bottom of the page, and the Office Action, dated 7/2/2002, end of section 7.

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chamber parts. The method includes applying an organic solvent to a surface of a chamber part, oxygen plasma cleaning the chamber part, ultrasonically cleaning the chamber part after the oxygen plasma cleaning, and rinsing the chamber part with a liquid that evaporates at a lower temperature than water after the ultrasonic cleaning.

5 The rejection does not indicate where the references show the limitation of “rinsing of a chamber part that evaporates at a lower temperature than water after an ultrasonic cleaning”. Accordingly, a prima facie case of obviousness cannot have been established for amended claim 15.

For this reason alone, this ground for rejection is traversed.

10 In addition, such a limitation is not believed to shown or suggested by the references. *Van Autryve et al.* teaches a “scrubbing” with an acid or solvent.⁶ But such a step is argued to correspond to Applicants’ application of an organic solvent, and thus cannot show the separate step of an evaporative rinse following an ultrasonic cleaning. Further, in *Van Autryve et al.* the scrubbing is performed on the process chamber, and thus is not suggestive is a step following an
15 ultrasonic clean. That is, to show Applicants’ claim limitations the reference would have to be modified so that the entire apparatus is subjected to an ultrasonic cleaning.

The *Background Art* and *Lu et al.* are silent as to ultrasonic cleaning and/or any evaporative rinse. Thus, these references provide no further showing of suggestion regarding the above limitation.

20 The reference *Laube* teaches ultrasonic cleaning in deionized water (DI). However, no evaporative rinse is shown or suggested, as the parts are rinsed in water, blown dry with nitrogen, and then baked.⁷ Similarly, *Mintz* teaches a DI ultrasonic clean, but such a step is followed by a nitrogen dry, and sputter etch clean.⁸

25 Accordingly, because the cited reference does not appear to show all limitations of claim 15, this ground for rejection is traversed.

Applicants’ have cancelled claim 17, as the Examiner found reinstatement of the claim improper.

⁶ See *Van Autryve et al.*, Col. 11, Lines 12-15.

⁷ See *Laube*, FIG. 1, and Col. 5, Lines 50-67.

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Claims 1, 10 and 15 have been amended. Claims 2, 17 and 19 have been cancelled.

The present claims 1, 3, 6-7, 9-13, 15-16 and 20 are believed to be in allowable form. It is respectfully requested that the application be forwarded for allowance and issue.

5

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* See *Mintz*, Col. 4, Lines 14-34.

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EXHIBIT A

Excerpts from

VLSI Technology, Second Edition, Edited by *S. M. Sze*

For Serial No.: 09/617,454
Applicant(s): BRANCO et al.

ITS

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VLSI TECHNOLOGY

Second Edition

Edited by
S. M. Sze

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it involves the bending of electric field lines due to surface topography. This off-vertical field also has the effect of enhancing ion flux at feature edges and leads to trenching. Since trenching is a small effect ($\approx 5\%$), it is often not noticed unless thick layers are etched. Deep etching also enhances the mechanisms of ion reflection and field bending.

5.4 OTHER PROPERTIES OF ETCH PROCESSES

The size and profile of the final etched feature are the most important properties of an etching process. Other process properties, however, such as those discussed in the following sections, also affect the value of a process and can determine if it is suitable for manufacturing integrated circuits.

5.4.1 Selectivity

The selectivity of a process is a measure of the etch rate of the layer to be etched relative to other material on the wafer surface. The selectivity is normally expressed simply as the ratio of these two rates:

$$S_{AB} = \frac{E_A}{E_B} \quad (21)$$

where E_A is the etch rate of the layer to be etched and E_B is the etch rate of a second material. The selectivity to the masking material and to the layer immediately under the layer to be etched are two important process parameters. The former usually determines the initial height of resist necessary to accurately transfer a pattern into a layer. For example, with a resist selectivity of 0.8, at least a 3750 Å thick resist is necessary to mask a 3000 Å layer. In practice, resist faceting and overetching demand an even thicker resist layer. The selectivity to the resist can also affect the final etched feature size if the mask does not have a perfectly vertical profile and if the resist etches isotropically. Problem 6 at the end of the chapter deals with calculating this effect. Multilayer resist schemes that result in thick (1.0–2.0 μm), vertical masks minimize the need for high resist selectivity and allow longer overetches.²⁵

Overetching is a term used to describe the common practice of submitting a layer to the etch process for a time longer than is necessary to just etch through the layer at one part of a wafer. It is because of this overetch that the selectivity to the then exposed underlying layer is also important. Overetching is necessary because all etch processes have some degree of etch rate nonuniformity and many etching layers start with nonuniform thicknesses because of nonuniform deposition conditions and underlying topography.

Figure 18 shows how topography can affect the required selectivity of a process. This figure illustrates the fabrication of an MOS transistor. Figure 18a shows the structure after the isolating field oxide is patterned, in this case by anisotropically etching down to the substrate in transistor areas. The gate oxide is

GATE MASK
FIELD OXIDE

UNETCHED MATERIAL

FIGURE 18

A schematic illustration of the etch process. (a) Before etch remove unetched stringers.

then grown, the gate mask is removed. Figure 18b shows the structure after the anisotropic etch. The gate oxide is etched, but it remains a thin layer of the material, frequently the field oxide, which cannot be removed. The drain region will be etched, but it is severe because the gate oxide is tapered outward, then the gate oxide requirement relaxes the area oxide, discussed in the next section, allowable density of transistor.

Problem

Plot required gate oxide angle of field oxide (s) is 0.5 μm

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